MODERN BULLET WOUNDS
AND
MODERN TREATMENT

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MODERN BULLET WOUNDS

AND

MODERN TREATMENT

WITH SPECIAL REGARD TO LONG BONES
AND JOINTS, FIELD APPLIANCES
AND FIRST AID

PART OF THE ALEXANDER ESSAY
FOR 1903

BY

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PREFACE

The Alexander Memorial Fund was instituted to perpetuate the memory of Thomas Alexander, C.B., who held the office of Director-General of the Army Medical Department from 1858 to 1860.

The Prize is awarded triennially.

The title of the essay for 1903 was "Injuries to joints and long bones caused by modern small-arm projectiles, with special reference to the appliances required and available on field service."

My thanks are due to the Committee of the Fund for kindly assisting me to publish this little book.

I have endeavoured in the following pages to throw a new light on the subject of

"Humane Wounds," and have suggested a means of providing readier first aid to the recipients.

Some diagrams which were appended to the original essay have been discarded on the ground of expense.

WOOLSTON, HAMPSHIRE
May 1903

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INTRODUCTION

The subject of this essay was announced before the Boer War began. One result of the war has been a great increase of our knowledge of modern bullet wounds. I shall endeavour to summarise the prevailing opinions partly by the light of my own experience.

Surgical details which are the common knowledge of surgeons will be mostly omitted, for the main principals of surgery are the same in military as in civil practice. No more striking proof of this can be found than the fact of the employment at enormous salaries of civil consulting surgeons in the late war. Just as the civilian Dutch officers and men and our own irregulars were at least equal to the regulars in mere shooting, so the civil surgeons were at least equal to the military in treating injuries. In the matter

of pure surgery the consultants were as welcome to the Army Medical men as to the wounded—their advice was eagerly sought; their opinions were deferred to.

The changes in the character of the missiles used for small arms led us to expect great alteration in the character of the wounds in modern war, as compared with those inflicted by the old leaden bullets. The opinion of the writer as to the extent to which our expectations have been fulfilled, and as to how far any improvement in the death-rate from wounds is due to changed types of injuries, will be unfolded in the course of this essay.

The principal innovations as regards the bullet itself are that it is made of harder metal and is less in diameter. Hence, *per se*, it should be less likely to split up and would therefore have much penetrating power, the latter characteristic being aided by the decrease in diameter.

The material of the projectile varies a little in different countries and for different rifles,

but in all there is a core of hardened lead and an outside coating, called the "mantle," of harder metal, such as nickel alloyed with copper. This mantle introduced a new element, in that it is apt under certain conditions to become dissociated from its core.

It is not only the bullet, however, which has been altered—the rifle and explosive have participated in the new order. By better rifling and improved explosives (acting in conjunction with a diminution in the resistance of the air owing to the smaller front presented by the projectile) a greater speed has been attained; also a flatter trajectory—this last being more likely to make a difference in the number wounded than to affect the character of the wounds.

Long bones for the purpose of this paper will be taken to mean the large bones of the upper and lower limbs; and the joints those into which these bones enter.

Wounds by the older firearms will be discussed along with those by modern weapons.

This will be advantageous for comparison, and will help us to an intelligent appreciation of the meaning of any changes in their nature or treatment.

The gradual progression from the spherical ball and smooth-bore musket has been in the direction of increased speed, penetrating and smashing power of projectiles. A marked change took place when the Martini-Henry type came into use. The bullet was still of homogeneous material but was hardened. Though at first of the same weight as the Snider (480 grs.) it was of smaller diameter. The more immediate of its predecessors, though conoidal, were soft, more or less hollow at either end, or fitted with plugs; they tended to become distorted in shape on impact; their successors tended to go through things.

This Martini-Henry and weapons like it are not yet quite of the past, and a good number of them were used against us in the war which has just ended.

For convenience the wounds of bones

and joints may be arranged in groups as follows:—

(1) Contusions with injury to periosteum but no fracture.

(2) Partial fractures not interfering much with the primary purpose of a bone as a portion of the framework of the body and as affording anchorage for muscles.

(3) Complete fractures.

(4) Comminuted fractures.

(5) Any of the foregoing involving a joint.

(6) Injuries of joints without injury to bones.

PART I

INJURIES TO BONES

Class I

CONTUSIONS

In the first class the projectile strikes the bone indirectly and glances off, or, more rarely, a spent missile may touch the bone without penetrating or fracturing it. The diagnosis of such an injury is uncertain. It might be inferred from the direction of the wound and pain produced in the part. Probing for diagnostic purposes in such a simple injury is undesirable. It is not unlikely to escape notice altogether, and to be brought to light some time afterwards by the separation of a flake of necrosed bone.

These injuries are not peculiar to the new

weapons, and treatment on ordinary surgical principles of the flesh wound is all that is required unless ultimate necrosis calls for the removal of a portion of dead bone.

Class II

PARTIAL FRACTURES

Class II. is of more importance, and includes varieties such as grooves, perforations, notches, fissures, &c. All are accompanied by loss of bone substance, consisting of fragments ranging from mere granular *débris* to large and variously-shaped pieces.

Grooves are met with most frequently near the heads of the long bones, the femur chiefly. Notches are more to be expected where a thin edge of bone is struck at right angles to the long axis—as may happen to the tibia for instance.

Perforations occur principally in the ends of the long bones. When the shaft of a bone is perforated it is almost invariably fractured,

though sometimes to a very slight degree, in a linear direction; but the fracture may sometimes extend to one side of the bone only so as to split off a piece of the shaft without breaking it across its entire width.

Chips come off at the opening of exit of the ball, where there is no resistance such as is presented by the bone at the back of the entrance wound. This happens in both head and shaft perforations.

The bullet is in these cases acting as a wedge, forcing fragments outwards in all directions at right angles with its long axis or with its line of flight, and also pushing bone in front of itself.

The simpler forms of these injuries call for little special notice. The broken bone surface can be felt in most cases with a probe if desired: in many, however, there will be fragments of bone in the wound of exit requiring to be moved and establishing diagnosis. In a simple perforation it is probable that both entrance and exit wounds will have closed under the first dressing. No attempt

to diagnose by reopening the wounds is advisable so long as all is going well. Where large pieces of bone are broken off they may be felt to move, and crepitus may be elicited. These injuries should be treated with splints and absolute immobility as if they were complete fractures, not only in order to afford the rest material to recovery, but also to prevent their being converted into the more serious injury by injudicious strain; the separated portions will often reunite if connected with periosteum.

A notch in the front edge of the tibia will be obvious enough; it can be seen and felt. Pointed edges on either side of the notch may require snipping off.

Are these forms of injury new to military surgery or are they more common than when the Martini-Henry type of bullet was in vogue? They are certainly not new—they are mentioned by authors who wrote before modern bullets came into use—but they are probably more common now. There are no adequate statistics from which to judge, and

the knowledge any way would be of little benefit to us.

There is one form of incomplete fracture which is certainly less frequent now; the cases in which the ball or bullet hit the bone and either failed to penetrate, or did penetrate but failed to get through, and consequently remained in the bone—portions of the hard external part of the bone being driven into the medullary cavity or into the cancellated tissue. Such wounds still occur now and then with partially spent bullets or ricochets. The writer has seen skiagrams showing the projectile, sometimes apparently unaltered in shape, deeply buried in the head of a long bone. The question then may arise as to whether an operation shall be undertaken for removal. As a rule, the exact position will not be discovered till some time after the injury and when the external wounds have healed. The advisability of operation then depends upon what, if any, disability is the result. When the bullet has been located before the external wound has

closed, if the part in which it is fixed can be easily got at and the bullet felt, there is no doubt an attempt should be made to remove it at once—that is to say, as soon as it can be done with proper attention to asepsis. This subject may be considered again under the head of "joints," as it is nearly always the case in these days that lodged bullets are complicated with joint lesions. Fortunately, skiagraphy has provided us with a means of solving doubts as to the situation of a projectile in a wound. In olden days they were often most difficult to find, and the searching sometimes did more harm than good.

Class III

COMPLETE FRACTURES

In Class III.—complete fractures—we have to deal with compound fractures due to direct violence of a specific character. (Comminuted fractures are not included here, see p. 25.)

They are mostly caused by the perforating bullet which has done more than simply perforate ; the centre of the fracture, *i.e.*, the point from which it radiates, represents the perforation. By perforation as a term we mean complete tunnelling through the bone and not mere penetration into its substance. Penetration may cause fracture and so may even mere impact.

As already explained there are circumstances under which the swiftest of modern projectiles loses velocity and becomes incapable of going through a bone. Ricochetting may dissipate much of the energy of the missile, and so also may perforation of other soft bodies, such as the long axis of a horse, for instance, or several men, and of hard bodies such as bones, wood, and many other things.

In the matter of variation in type it may be said that a gunshot fracture may be of almost any variety—transverse, oblique, transverse and oblique combined, or any derivative of these which can be imagined or given a name to.

The diagnosis of these fractures as fractures rests on no features different to those met with in compound fractures encountered in civil practice. The chief difference between the two classes lies in the fact of loss of bone substance being the rule in the gunshot injuries and in the presence of portions of bone substance in the wound, where they are liable to act as foreign bodies, being in consequence more common in the military than in the civil injury. The question as to whether there is simple fracture or comminution is more difficult to determine. But unless comminution be very extensive (when the many rattling fragments or, if there has been much pulverising, the big gap in the continuity of the bone, may be easily felt) it is not important for us to know ; the line of treatment will be the same in either case ; all spicules of bone do not necessarily die and become foreign bodies. Moreover, it is not easy to say where comminution begins, as far as terms are concerned, and it might be thought that

there is no such thing as an uncomminuted gunshot fracture—it is really only a question of degree—so, then, we need not be too much troubled about accurate differentiation.

If the wound of exit from the soft parts of the limb is large and ragged the inference is that bits of bone have been driven out with the bullet. There may be others to come ; but some of them will be near the exit wound and will find their own way out. A moderate increase of the exit aperture may be due to an alteration in the shape or direction relative to long axis of the bullet itself. Nevertheless, in such a case it may be permissible to make a modest search for loose portions of bone, careful guard against sepsis being taken. In most cases, though, some days will have elapsed before explorations can be conducted with thorough antiseptic precautions, and everything must then depend on the state of affairs presented. Unless the wound is already septic explorations should not be lightly undertaken at such a stage ; let well alone and await developments. If

it is septic the wound will have to be searched in every corner by the long nose of a syringe or irrigator containing carbolic, sublimate, or other antiseptic lotion, and the small fragments of bone, if any remain in spite of the dislodging effect of the lotion, can be removed at the same time.

Similar considerations must guide us in the rare cases in which a projectile has lodged in the wound. Unless actually in sight—an unlikely event—search should be deferred until it can be carried out with due regard to the patient's safety.

Having said that the method of dealing with these fractures is such as that found in the text-books on general surgery, we may postpone the questions connected with field appliances suitable to carry out that method until nearer the end of the essay.

Amputation can scarcely ever be necessary on account of the bone lesion alone in the uncomminuted fracture, though it may be deemed desirable on other grounds connected with the muscles, nerves, and arteries.

Septic conditions, such as osteo-myelitis, &c., may, however, call for operative interference, and will be referred to again after comminuted fractures have been dealt with. Owing to the relatively large amount of bone injury as compared with damage to the soft tissues, in the compound fractures due to gunshot, acute septic affections of bone are more often met with in the military than in the civil hospitals in proportion to the number of cases of compound fracture treated.

Class IV

COMMINUTED FRACTURES

In Class IV.—comminuted fractures—we come to a type of injury of much more importance than the foregoing, one of the most serious in the whole range of military surgery when it affects the thigh-bone. To a great extent they are a special type of fracture, and though cases due to accident or homicidal attacks find a place in civil

hospitals it is in war that large numbers of such injuries may be met with.

In some of the before-mentioned injuries there is loss of substance, there might be foreign bodies in the wound. In the class now under consideration foreign bodies, that is, pieces of dead osseous tissue, are the rule.

The injuries may be so extensive and far reaching in character as to raise the question of amputation irrespective of the extent of damage to the soft tissues, vessels, &c., in the neighbourhood.

Whether the worst of these wounds are due to the impact of a bullet in the earlier part of its flight from the muzzle of the rifle or at long ranges is a matter which has not yet been settled; the balance of opinion is that they are inflicted at the shorter ranges. We know that the bullet sometimes causes the less severe injury to the bone and at other times gives rise to woeful destruction. But for the purposes of diagnosis and treatment it matters little whether the injury was sustained at short or long range, and

the point may be left out of further consideration here.

It has been shown already that the bullet tends to set up a radiation of lines of fracture from the point of impact, which last means, as a rule, with the modern rifle the point of perforation. Also that the radiation may be of only one or two lines, and these of moderate extent. But there is the other extreme in which the lines of radiation may constitute a many-pointed star, some of the points of which may split the bone in almost its entire length.

The injuries are similar in all the long bones, though the amount of bone in fragments actually driven out of the wound is greater in those having little fleshy covering, as the bones of the forearm and the leg in certain portions of their length; this, of course, makes differences in the appearance of the skin wound of exit. The amount of bone actually destroyed in the smaller bones is apt to be relatively greater than in the large ones, and very severe injury to the

second bone struck when the bullet goes transversely through both shafts near the ankle or wrist—an instance is given where the hand was almost severed from the forearm—is not uncommon.

Some General Considerations

The Argument

The injuries of bones will be considered collectively, but references will from time to time be made to particular bones.

Some bones have been more frequently wounded than others in certain campaigns. Writers have laid down the proportions, with a view to estimating amount of surgical appliances required for particular parts. Owing to their more exposed position bones of the upper limb would be hit oftenest when men were lying down. When advancing in the erect posture the lower limbs would suffer most owing to their larger area. Obviously there will be variation in the relative frequency of hits of different bones

according to the style of fighting, the ground and cover, &c., in different battles and campaigns. The enemy's position and his firing posture will also have effect. In some Malay fighting the short Malays fixed their guns at middle height in the stockade loopholes; the tall Sikhs received the missiles in the pelvic region. In a fight in West Africa I found all the killed of the enemy hit in the head, our tall West Indian men had been firing from behind a high fence on which they rested their rifles.

In the olden times comminuted fractures of the thigh-bone were held to call for amputation. Thus Guthrie says: "A fracture of this nature in the middle of the thigh will often extend downwards into the condyles, and as high as, though rarely into, the trochanters. These are cases for immediate amputation." He thought, however, that if the injury were confined to the lower half of the femur an attempt might be made to save the limb. Ballingall of Edinburgh, in 1852, held similar views, but was

still more insistent on the need for amputation. He said that in comminuted fractures, of the bones of the leg even, the deaths will be ten to one recovery if amputation is not resorted to, and adds: "In the case of the femur the indication is still more explicit and distinct." Stromeyer held the opposite opinion, but G. H. B. Macleod, after the Crimea, remarked that "straining after conservatism . . . was one of the main causes of the mortality which attended these injuries." Hamilton of America, in 1861, concerning gunshot injuries of the thigh, held that "conservatism has ruled too much." As late as 1880 Surgeon-Major Porter does not seem to have made up his mind whether conservatism was to be recommended or not. Finally, in 1887, we find Brigade-Surgeon Godwin perpetuating the same state of indecision, quoting the famous authority, Surgeon-General Longmore (then Professor of Military Surgery at Netley), among others in his (Brigade-Surgeon Godwin's) revision and editing of Surgeon-Major Porter's book.

It is worth noting here that these opinions prevailed long after the introduction of the Martini-Henry.

The wounds, for many years, at all events since conoidal rifle bullets came into use, had been similar in nature to those met with now. The cleaving bullet was larger and didn't travel so fast certainly. Yet the fissuring was at least as extensive, though there was less splintering up into small fragments in the immediate neighbourhood of the point where the bullet actually struck the bone. When Brigade-Surgeon Godwin wrote his book the Martini-Henry (the same weapon which has been largely used by the Boers in the late war) had been in use for a long time. It and some of the continental rifles of the time had hard bullets of small calibre. Stress is here laid upon this point as it bears upon the line of argument on certain questions to be presently discussed.

In some respects the modern injuries to bone are worse than their predecessors: or let it be put rather in this way—some of the

bone injuries by the new bullet are more severe than those inflicted by the older projectiles. On the other hand, the wound of entrance, and to a less extent that of exit, in the soft tissues may be in a general way smaller. Some of the injuries to bone, too, especially the ends of long bones, are, as before described, milder than of old.

"Straining after conservatism" in the late war has been rewarded by marvellously changed results. What has been the procedure in treatment and to what may be attributed the great improvement? Statistics throughout are not available yet in support of the idea that there has been a change for the better, but opinions as to conservatism of thigh wounds, judging from common report among those who have had recent experience, seem to be generally favourable. Makins in thirty-two fractured femurs (three known to be by Martini-Henry) had not quite 16 per cent. of deaths, and less than 19 per cent. required amputation at any stage. He compares this with the American

records of the War of the Rebellion, which showed a mortality rate of over 40 per cent. The better results are not evidenced merely in lessened mortality but in a reduced average period under hospital treatment. The thigh is selected for purposes of argument because of the severity of its wounds as to mortality rendering improvement more indisputable. All the bones have shared in the advantages, but it is more in the way of rapid recovery than of lessened mortality—of infrequent resort to amputation, as far as concerns the leg and upper limb. Conservatism has long been in practice in these situations with more or less success.

Is the beneficent change entirely due to the comparatively slight alteration in the general type of the wounds themselves—the bone lesions, that is? No! in the writer's opinion it has been brought about by a number of influences, and an endeavour is here made to explain them and to show how they have combined to render more hopeful the conservative plan of treating fractures.

This side of our subject is not so unimportant as at first glance it might seem to be, and it ought to be given due prominence lest in future too great a confidence in the humane character of the new weapons should lead to slackness in certain directions; to a relaxation in the observance of various matters conducive to the welfare of the sick and to a resultant loss of the prestige gained by the surgeon's art in the recent war.

It must first of all be admitted that the outlook in the case of bones has been improved in relation to, and along with, that of its enveloping soft tissues. The older bullets made a bigger flesh wound and devastated a greater area of the tissues in the track of the wound. It is especially in the proximal side of a wound that the change is manifest. This part of the injury corresponds essentially to that of an ordinary flesh wound by gunshot, *i.e.*, where there is no fracture. It is a clean-cut hole of small diameter, thanks to rapid flight and small calibre of the bullet. Experience has shown that it commonly heals

up at once under a single field dressing. One possible avenue of septic infection is, therefore, closed very soon after the receipt of the wound: theoretically, it may be claimed that this alone ought to reduce the number of septic cases by nearly half. The writer believes that this early closing of the wound or wounds, combined with the intelligent use of antiseptics and of aseptic materials, above all greater cleanliness of the hands of the surgeons and the appliances used by them, as well as the practice of leaving the wound alone as much as possible, have contributed more than anything else to the improved position of conservative surgery.

The question of involvement of the vessels and nerves remains pretty much the same as it was when the older firearms were in use insomuch as the subject under discussion is concerned. They may perhaps be less frequently injured, though this is not definitely proved, and the large nerves are probably less likely to be complete severed,

but these items can affect the general results to but a slight degree.

We may now advantageously review some of the old practices and their results. First of all let us direct our attention to some of the famous Baron Larrey's procedure in the treatment of compound fractures. "He dresses them with compresses and cushions of straw, leaving them undisturbed till the completion of the cure"; to quote Ballingall, who had also seen favourable results follow the immediate envelopment of a native's wounded limb in potter's clay in Egypt. He (Ballingall) was so impressed by this and Larrey's cases that he adopted the same style of treatment as the great surgeon. For some reason or other, however, he was not so successful as the illustrious Frenchman. Larrey seems surely to have foreshadowed modern treatment, and a clue to a possible cause for difference between Ballingall's results, and those of the surgeon whose teaching he was following, is suggested by a perusal of Rutherford Alcock's work. Alcock gives his opinion that the continental

system of dressing wounds with wine and aromatic herbs instead of poultices was a good one. This seems like an unconscious approach to antisepsis on the continental side. Alcock's own results in Spain were bad enough in all conscience: of twenty-one gunshot fractures of the femur no less than sixteen died, four lived after amputation, and one was a hopeless case after eighteen months treatment.

Again, we know how comparatively recently the absolute disinfection and frequent washing of the doctors' hands in antiseptics has become universal. Together with this habit has grown up the practice of intelligent avoidance of unnecessary examination and fingering of the wounds.

Read the following instructions of Sir Thomas Longmore—written in 1877—and then try to picture to yourself the state of the average medical finger—not to speak of the patient's skin—in the Crimea, especially on the days when there happened to be a rush of surgical work. "Of all instruments for

making a complete examination of a gunshot wound, as well as for exploring for foreign bodies which may be lodged in it, the finger of the surgeon is most appropriate. . . Exploration by a finger will establish the fact of a joint being opened. . . An incision to the necessary extent should be made at the margin of the opening extending through the fascia to facilate its ingress. . . The finger should be inserted towards the deepest part of the wound." Carbolic acid had come into use before the date of the edition of Sir Thomas Longmore's book above mentioned, but it had not been adopted in the Crimea though it had by the French in the Italian war of 1859. It had, too, been used in the Franco-German War on a big scale, and Lord Lister had written instructions on his method. Sir Thomas, however, wrote: "Unfortunately to any one practically acquainted with the state of things after battles, it will be at once obvious that the plan described must be on almost every occasion of such an event taking place incapable of execution." And

again, "Even if the germ theory of suppuration be admitted. . . it is scarcely credible that . . . the rigid exclusion of germs can ever possibly be carried into practice in the field." Even in the eighties Surgeon-Major Porter's Handbook gives instructions how to keep maggots out of stumps, &c.

When the principal teachers of army surgery held such views we were a long way indeed off our present practice.

For all that, the returns, given by Sir Thomas Longmore himself in another part of his book, seem to show a marked improvement in mortality statistics. Thus, the French in the Crimea lost 37·6 per cent. of wounds of the lower extremity; three years later in the Italian War they lost only 17·35 per cent.; joints were probably included in these reports. Again, the British in the Crimea lost 21 per cent. of injuries to joints, whereas in New Zealand, a few years later, they lost only 15 per cent. In the lower extremity the ratios were as 8 to $4\frac{1}{2}$ per cent. respectively. Exactly what were included

in these terms we don't know, but the French show no special list for joints—it doesn't matter for comparison. These last English numbers, it may be remarked incidentally, seem low, but it must be borne in mind that minor flesh wounds from the foot upwards are included. Any way they undoubtedly show a distinct advance.

Sir Thomas Longmore's dressing "in simple perforating flesh wounds, and in gaping and lacerated wounds by small projectiles," was "lint moistened with plain water at the ordinary temperature." The lint was kept moist. Linseed poultices were still in use. He is not in favour of the poultices in 1877, and writes half a page in explanation. He also casually mentions a new practice of mixing antiseptic material with the water for moistening the lint applied to wounds.

Compare the present-day practice with Sir Thomas Longmore's, as above described. An excellent, perfectly aseptic field dressing, for the adoption of which the Medical Department of our War Office cannot be too highly

praised, is applied at once (dry) to the wounds of entrance and exit. The patient is then fairly safe until he can be attended to without undue hurry and with proper regard to cleanliness. If waiting is inevitable, the dressing is either left on or, should it have become loose or displaced, a fresh one of the same kind is applied. In a large proportion of cases the first dressing forms with the blood an impervious seal to the wound.

It was my good fortune in South Africa to have handed over to me in a body the charge of a number of wounded men who had received first dressings and little more. The patients were in a church—all the lying-down ones on the floor. They were attended to in order of urgency. The medical *personnel* was much less in number than was required. Consequently in many cases the dressings were not removed for some days. What was the total result? Excellent! In many instances the removal of the first dressing showed that no further application was really needed—the wounds were closed both

ends. In most of the others the wounds looked healthy ; they were wiped with swabs moistened with corrosive sublimate lotion and covered up again. When the oozing came through and had not dried the dressing was renewed in the same way daily, splints being removed for the purpose if necessary. In some where suppuration was evident, the cavities were syringed out with sublimate or carbolic lotion. All did well except one with brain injury, and one abdominal case. Two eyes were enucleated and one middle finger amputated. On a table alongside the medical officer when at work were large basins full of boiled water and antiseptic lotion—sublimate and carbolic. Hands, instruments, &c., were clean and were disinfected between each dressing. No dressings were entrusted to any one except the surgeon.

It is not any one or other antiseptic application which brings about these happy experiences. The simple iodoform alone has effected a revolution in surgery. If applied in sufficient quantity its effect is somewhat

continuous as it mixes with discharge from a wound. Here is an instructive case seen some years ago in Malaya; it shows, moreover, clearly enough that the South African chirurgical triumphs were not necessarily due to anything peculiar to South Africa or the weapons used in that country. An Indian Sepoy employed in the service of the Pahang Government was attacked, while in a boat, by Malay warriors. He slipped over the side of the boat and supported himself by the left hand on the gunwale while he fought with the paddle in his right. He was miserably hacked over the left arm and shoulder with native swords—not at all aseptic weapons. He was crimped like a codfish, having received no less than twenty-five gashes, one of which went into the head of the humerus and notched the collar-bone, while another cut clean through the last mentioned bone. The cut surfaces of the clavicle were exposed in the gaping wound and the subclavian could be seen beating. The Indian apothecary to whom he was first

brought washed his wounds, covered them plentifully with iodoform, and bound them up with wool and bandages. On reaching Singapore by boat four days later the man had every wound perfectly clean and he made an uninterrupted recovery. In the China-Japan War official report—Japanese—Baron Sanoyeshi suggests that iodoform may be useful as a temporary dressing to shell-wounds, as cleaning the inside of wounds was difficult during the fighting. As might be expected suppuration was the rule in the large wounds, yet the results were better than small-arm wounds of pre-antiseptic times. The wounds inside and out were treated with $2\frac{1}{2}$ per cent. carbolic and sometimes sprinkled with iodoform (the iodoform was only used in one or two instances, but seems to have found favour). Dr. Saneyoshi's own words are : " In the hospitals we resorted to the conservative surgery as much as we could, amputation or resection for compound fractures or injuries to the joints was avoided whenever possible, and this treatment was attended with favour-

able results." Taking into consideration that pieces of clothing are the rule in shell wounds, that the amount of bacteria food in the shape of crushed tissues in the neighbourhood is great, and that in the more extensive wounds and burns antiseptics had to be used with caution for fear of poisoning, the Japanese Naval Report supports the suggestion that the heightened chances of getting over a wound are owing more to germicidal lotions and dressings than to anything else.

In tropical Africa, where the wounds were generally made by irregular chunks of bar-iron (known as pot-legs) and by stone projectiles from old flint-locks our results were, in the writer's personal experience, just as good as in South Africa.

Some surgeons of eminence ascribed the favourable course of wounds in the Boer War to some extent to the salubrious climate of South Africa, oblivious of the evidence of the typhoid and other outbreaks, that the soil and water are polluted.

There is one side of the question which has

been rather overlooked by the public in the general rejoicing. That is, the improvement which has been going on steadily from year to year in the medical service itself *pari passu* with the development and progress of the science and art of medicine and surgery in our centres of medical education. The service has gone on step by step, fighting for improved food and clothing for the soldiers (especially food), and it has perfected its own war equipment to a marvellous degree. A modern general hospital pitched and prepared for the reception of its 520 patients is a very fine sight indeed. It is very little, if at all, inferior to a great many fixed civil hospitals which have taken years and years to arrive at their present stage of moderate approach to perfection at home. It is, too, superior in many ways to some of our permanent military station hospitals; these latter have not had the benefit of war stimulus sufficient to overcome an economical Treasury.

A great pity, one thinks, that more critics could not have seen some of the hospitals in

that stage instead of pouncing upon them when they were suddenly swamped with more than three times the number of patients they were intended for. A marquee with six or eight fully equipped beds with spring mattresses, sheets, counterpanes, &c., takes the place of the collection of men crowded together on trestles. Other things have advanced in the same way, especially surgical instruments and materials. The science of hygiene, which had its birth in the army, is better understood than ever. The quiet unobtrusive work which has gone on towards this better state of things has not received the credit which it deserves from the public, which is now first admitted, on a large scale, to look on the inside working of things at our wars, and has therefore scant experience of anything to compare it with. Still, these things, in the hands of a much better organised and more highly trained *personnel* than we have ever known before, must have added a little to our success in the late campaign.

It must not be forgotten, moreover, as contributing to the happier state of affairs which we claim to have arrived at, that better commissariat, transport, and ordnance departments have become a factor in the conduct of war. The supply department in this war has been most marvellously efficient, and, of course, its efficiency would have been of no avail if the transport department had been unable to convey the supplies to the places of distribution. The soldier has been comparatively well fed in the matter of quality, variety, and quantity, and this improved feeding must have helped, though perhaps only to a slight extent, to put him in a better condition to bear severe injuries.

In the older wars scurvy rendered the chances of the patients worse than they might have been. Alcock in the Peninsula found the troops under his medical care ravaged by a gangrenous complaint which, from his description, would seem to have been ergotism. These terrible complications evidence a state of personal insanitation which

must have reduced the troops to such a generally unhealthy condition that they were unfit to endure wounds or operations. Guthrie says that in 1813 over 37,000 sick and wounded were treated in three months, a number nearly equal to that of the whole army. In the first winter of the Anglo-Russian War in the East it was even worse. From November to April, with an average strength of, roundly, 31,000, over 10,000 actually died. Scurvy was again to the fore. It is a matter of common history, of course, that the supply department utterly failed in the Crimea, though, thanks to public clamour and generosity, things cleared up in the latter part of that war.

We have practically no scurvy now owing to the good dietary and, above all, to the exertions of the commissariat department (stimulated, when it flags, by the reports of the medical officers) to supply fresh rations—meat and vegetables—whenever possible.

Whether in a big European war we shall be able to feed an army as well as we did in South Africa remains to be seen.

The hardships of our soldiers in the Boer War though bad enough have been nothing compared with those in former wars, if we are to credit history; indeed they cannot well have been so taking the campaign as a whole. Except for the sieges things were conducted in a comparatively comfortable manner. The outposts might be wet and cold at night, but they were generally sure of a hot drink and a warm drying sun to cheer them up at daybreak. We have, too, had more doctors, nurses, and so forth, than in any other campaign. Field service in our own country would be much more trying than campaigning in South Africa, especially in the colder half of the English year. It will therefore be as well to be not too self-satisfied — to suspend final judgment more or less until we have had a war on a big scale in an inhospitable cold climate where the wounded are many and the doctors proportionately few; where we are not absolutely free from interference with our seaward supplies, and so on.

In South Africa the large batches of wounded (and they were not large compared with, say, the Franco-German War) were dealt with fortunately before the great epidemic of enteric arose to tax our energies and resources.

Comminuted Fractures—Treatment

In spite of the views set forth in the foregoing remarks, I still hold comminuted fractures from gunshot to be most formidable injuries. Even nowadays they are very liable to become septic—a condition probably conduced to by the large amount of devitalised tissue, apt to be surrounding such wounds, affording a secure asylum for any organisms which may have got into them. When so affected they are naturally more difficult to treat according to the part concerned. High up in the thigh it is not easy to reach all the areas involved, when once the bacteria have got a start; and here, too, if there is much delay in coming to a decision the disease may

soon be so far advanced that there is no chance of success in operative treatment. Diagnosis then, early diagnosis, becomes of increasing importance. A muscular bag of bones in the thigh is before you. Are you to amputate at once or try to save the limb? The patient leaves it to you to decide; septic germs are possibly in the wound in greater or less abundance; you don't know whether, if they be there, they will die off quickly or increase and multiply; whether a local growth of bacteria with slight toxæmia will result or a systemic bacterial invasion threaten the patient's life. For the medical officer in the field there can be no greater responsibility than this. What is he to do? Ninety-nine out of a hundred surgeons probably would say "wait awhile." If the main artery is still intact he ought to wait. Some have urged that he should be guided by consideration of distance from the nearest permanent resting-place, but surely this is begging the whole question. In practice any way it is rarely absolutely necessary to move such cases to any distance.

In South Africa on an occasion when the writer was in charge of a hospital—an extemporised hospital—he made a point of keeping all fractures till they had become set (to use a popular term for union of bones). The results were very satisfactory among fractures of all kinds, and he fails to see why it should be necessary to move such cases so much as was done in some parts of the theatre of war. The craze for getting the front clear was a little overdone perhaps; but whether the same opinion would have held good if another big fight had caused a deluge of wounded for whom there would have been scant accommodation is another matter. All the same, it would seem at present that the risk should be run; the condition of the patients would not after all be much worse then than if they had been moved too early. If the circumstances be such that a patient cannot be treated on the spot or in the near neighbourhood it is certain that conveniences for operating will be none too good. There can be little harm in waiting and watching,

inasmuch as the operation possible to-day will also be feasible to-morrow. Moreover, there are few circumstances under which a broken limb may not travel as comfortably and safely as a stump. Some surgeons of first rank in the late war indeed have stated their opinion that newly amputated stumps bear transport very badly—that they slough, &c. So, then, we may leave this latter point out of further discussion. The hasty amputation of limbs cannot be too highly reprehended. Few medical men of any experience cannot recall cases in which the patient has retained the use of a member by disregarding advice to have it off. The keen surgeon should ever try to keep his art under control. The army surgeon has been thought to err in the opposite direction. It is true that if the patient does recover it may be after a long illness; on the other hand, the illness may be short, and, after all, who would not choose a long illness in preference to the loss of a limb.

But if the main artery be destroyed? Well, we may still wait on the chance of a collateral

circulation being established, unless the soft tissues are extensively pulped in a direction transverse to the limb's long axis ; but this can scarcely ever be the case in a modern gun-shot injury except to a limited extent on one side—the exit side—of the wound. It would seem to be likely to happen only at the wrist or ankle where the fleshy coverings are scanty in part of the circumference of the limb. No absolute rule can be laid down ; particular cases must be left to individual judgment.

Concerning nerve trunks—as before mentioned, complete division is more unlikely than of old, and is most difficult to diagnose. This is well illustrated in the following case : Private T—— was shot in the arm at close quarters with a Lee-Metford. From the course of the wound, and from the fact that the man had drop-wrist, it was thought that his musculo-spiral nerve was severed. Two or three weeks later an operation was undertaken to unite the divided ends. But the operator failed to find them, or the nerve in continuity either, so the wound of operation

was closed. The man's name was noted for invaliding. Six weeks later he was found to have recovered full use of the limb and he went to his duty. It is assumed now that the nerve was injured, but not completely divided—perhaps merely concussed.

In the smaller bones where there is little fleshy covering—as near the wrist and ankle—the destruction of a portion of both bones may leave the extremity dangling by little more than a piece of skin and a narrow strand of muscle on one side only (a condition similar to, but a little worse than, that alluded to above, where both bones are not necessarily injured). The first wound by the Lee-Metford that ever came to the writer's notice was of this character. It occurred in 1898, and was inflicted at a range of a few feet, owing to the accidental discharge of a rifle by a soldier in camp. In this case the hand was amputated forthwith, and there can be no doubt that no other course is open to us under such circumstances with any prospect of success.

As to the treatment of comminuted

fractures, when we do elect to try and save the limb, as has already been maintained, there is no essential difference between the management of these cases in civil and in military life, though it is true that we have not always in the field the same convenience in appliances, &c., as in fixed institutions. It will be understood that the above statement is not intended to mean that we do not in the field get a greater experience of the special type of comminuted fracture due to gunshot.

The less we interfere with a healthy-looking wound the better. If there be a gaping exit and loose fragments of bone are evident they should, of course, be removed.

The antiseptic dressings now supplied in the field medical equipment are quite adequate. The amount of carbolic acid in our panniers seems small, but this can be remedied, and we have always the sublimate tabloids in plenty. With these and boiled water we can meet any emergency. There is, too, always plenty of carbolic acid at the general hospitals.

There is no special splint which can be

considered fit for all cases in any particular limb. The resourceful surgeon will never be at a loss to find something suitable. In one of the best recoveries the writer has had, the splint used for a badly fractured thigh was a biblical wall map on rollers. This novel surgical appliance was found in the vestry of a Dutch church, and when rolled was found to make an excellent padded long splint, the space between the ends of the two rollers affording a good grip for the bandages. It was used as a Liston with perineal band, &c.

This somewhat discredited form of splint (the Liston) has a great deal to recommend it for rough work. It is unpleasant to the patient and apt to be painful—a pain repeated during readjustment—but as far as the writer's knowledge goes in thigh fractures, the results are as good as in any form of treatment. Everything depends on the thoroughness of the extension and application. It requires, too, to be constantly watched and frequently readjusted (if to be used throughout the case). This last is

irksome to the patient and troublesome to the doctor ; it is therefore liable to be shirked by the less thoroughgoing and conscientious members of our profession ; all the same, it is the thing for field service anywhere except at the fixed hospitals. The writer has in his mind now a case in which there is absolutely no shortening or lameness of any kind after a bad thigh fracture in which Liston's splint was used. Withal he is bound to say that there is a permanent scar on the buttock from the pressure of the perineal band. This last, however, is a slight matter and is not essential to the success of the line of treatment.

A good deal of unwarrantable apprehension exists as to the danger of removing splints to find out how things are going on. I have seen no harm from this practice, and don't see how it can come about if moderate care be taken. Loss of extension can be guarded against — the slight movement of bone fragments in a mass of soft callus can do no harm, and, of course, we are not going to

move the bones unnecessarily; we have some one holding the limb to prevent untoward occurrences. But I have seen queer deformities from the habit of putting up fractures and leaving them alone till the bones have united. From the point of view of the patient himself, or of his feelings at the time, it would be nicest to let the broken limb be disturbed as little as possible; but the patient who is left with a distorted leg or arm will not thank you afterwards for your over-consideration for his immediate comfort when under your care. To avoid being misunderstood, it may be here remarked that the use of splints so arranged as to allow the wounds to be dressed, and perhaps the line of fracture to be in view, is duly appreciated.

I shall have more to say farther on about the earlier treatment of fractured limbs on the actual battlefield.

A glance at the illustrations in Esmarch's handbook will give a better knowledge of splints than any amount of reading or

writing. Some of them would not be likely to be available except in European warfare, but others are of such a character that the provision of the component material is the only thing necessary to enable the surgeon to rapidly manufacture his own splints. The principle upon which army splints are furnished should be this one of capability of rapid conversion of material into appliances to meet the requirements of individual cases, and this has been recognised to some extent by our War Office. In the field medical panniers, for instance, we find, in addition to the long splint, some perforated zinc sheeting, and the tools for fashioning it to the shape required. The subject of appliances will be referred to again.

The fixing of bones by wire, pegs, screws, &c., has been done now and again in the late war with good results. It seems essentially a fixed hospital form of surgery, not to be advocated for general field practice. For all that, it may be required in excisions ; in the knee, for instance, good union would be not

easily obtained without some fixation of the kind.

When septic disease of a limb gets beyond control and amputation is decided on, the operation will be the same as in ordinary surgery. A similar view applies to resections, which will be alluded to further on when treating of joints. A detailed description of varieties of operations would be foreign to the subject matter of this essay. Sepsis in the shape of osteo-myelitis often necessitates amputation. In home practice scraping out the medulla and administration of anti-streptococcic serum have been resorted to, especially where the femur is concerned and when fever is high. In ordinary cases, however, if operation is necessitated, this disease will be stopped with greatest certainty by removing the whole of the affected bone.

Joints will be dealt with in Part II. of the essay, which will conclude with some general considerations as to "first aid," &c.

PART II

INJURIES TO JOINTS

Class V

INJURIES TO BONE,

similar to some of the foregoing, but involving the joints

Injuries of joints are in great variety, but they mostly, in these antiseptic days, have importance in proportion to the amount of bone injury with which they are complicated.

Many of the kinds of bone wounds which have been mentioned in Part I. may also be met with in the joints. There cannot be long fissures of course, but the ends of the long bones may be chipped, grooved,

perforated, split, or hopelessly smashed. The fissures of long bones generally stop short of the diaphyses. This was noted by the old writers and still holds good; but fractures of the distal ends of the diaphyses themselves may extend into the joint.

It will be useful before we proceed further to refer briefly to the older authorities as to the practice and as to the prognosis of joint injuries in the pre-Mauser days.

Guthrie wrote, "gunshot fractures of the head and neck of the femur have hitherto been fatal injuries, unless the whole extremity has been removed"; and again, "wounds of the knee joint from musket balls, with fracture of the bone composing it, require immediate amputation." But, with regard to the upper limb, he wrote, "an upper extremity should not be amputated for almost any accident which can happen to it from musket shot." He urges the advantages of excision and partial excision of the head of the humerus for shoulder injuries. Many

cases, even in his days, in which bullets were buried in the head of the humerus, did well after the bullet and loose pieces of bone had been removed. Excision of the elbow joint also found great favour in Guthrie's eyes, as a substitute for the older operation of amputation, when the articular ends of the bones forming the elbow joint were broken by musket ball.

Excision of the head of the femur was tried with poor results in the Crimea.

Knee-joint resections were not much better, and Macleod formed the opinion that amputation was the correct operation for knee-joint penetrations. Surgeon-General Longmore seemed to be more or less of the same opinion. Hamilton, U.S.A., laid down a rule that fractures implicating the knee joint, or even near the knee, required amputation; but he held with excision for hip-joint wounds. Excision, moreover, was in vogue for joints of the upper limb. The Franco-German War gave a turn to public opinion; for all that, Langenbeck had 71 per cent. of

deaths in hip-joint cases which he tried to save, and so many as nearly 84 per cent. in resection cases in the same joint. Knee-joint wounds were still considered to require amputation—by the generality of British surgeons that is to say—notwithstanding that Langenbeck, from experience gained in the Danish War, spoke up for the conservative treatment. Langenbeck himself saved eleven out of eighteen cases. Yet Sir William Mac Cormac * was decidedly of opinion that amputation was the proper treatment.

About the ankle joint there was still much doubt, but, on the whole, resection was not in favour; conservatism was advocated for all except the worst cases, when amputation was resorted to.

To briefly recapitulate. The consensus of medical opinion in the early seventies was as follows:

Conservatism, with resection in some cases, was the treatment for hip-joint injuries

* Sir William had personal experience with an ambulance in the Franco-German War.

because amputation at that joint was such a fatal operation.

Amputation, in all except the slighter cases, was the rule in knee-joint injuries.

Conservatism, tempered with judicious excisions, was the plan of treatment for other joints.

Experience gained in the Russo-Turkish War altered the general opinion as to knee-joint injuries. Dr. Reyher had only 16·6 per cent. mortality in selected cases, which came under antiseptic treatment from the first. In cases previously fingered or probed, and later treated antiseptically, the deaths were 83 per cent., and in cases not treated aseptically or antiseptically at all, nearly all died —95·6 per cent. Bergmann was still more successful, he lost only one case out of fifteen treated; two of the fifteen, however, were amputated. Surgeon-Major Melladew, a British medical officer of the Guards, after his experience during the same campaign, also spoke highly of resection for wounds of the knee joint. The British surgical authors

after this advised antiseptic treatment, or amputation when that could not be carried out. Resection of this joint was still considered unsuitable for the field. It is noteworthy that the antiseptic treatment of Reyher, and that recommended afterwards, consisted of complete washing out of the wound with carbolic and draining with india-rubber tubes. Whereas Bergmann, the most successful of all, treated the wounds more after our present fashion. He cleansed the skin with carbolic and then covered up the wound permanently with dry antiseptic (aseptic ?) material.

From this onwards wounds of knee joints have been regarded with gradually decreasing gravity. The stage now arrived at is, that wounds of this joint are thought to be rather less serious, on the whole, than wounds of the shafts of the long bones. There is no doubt that the new bullet is here an important factor—much more so than in the case of the shafts of bones—owing to the fact of the comparatively soft osseous tissue offering less

resistance to the projectile. The ends of the bones are more likely to be perforated than splintered. It is as the difference between an apple and a cocoa-nut. Moreover, in the case of a clean perforation the wound of exit is relatively less than in those injuries in which splinters of bone are driven out by the projectile, and such being the case the risk of septic infection is lessened.

Retentions of the bullet in the joint are, too, of much less frequent occurrence than they used to be, not only in the knee joint but in all. They are met with now and again —probably due to spent bullets or those which strike irregularly; or again to bullets at the end of a long wound track in which bone has already been encountered. An instance has been given, in front, of a modern bullet, unchanged in outline, embedded in the head of the humerus. In this case it was only recognised by skiagram and gave so little trouble that it was left alone, the external wound being healed. The discovery of a lodged projectile, formerly a matter of

some difficulty, entailing much undesirable interference with the joint, has been immensely simplified by the X-ray apparatus. Its situation can be so accurately marked out that only the minimum amount of operative procedure is required for its removal.

Septic conditions can nowadays be the only indication for amputation after small bullet injuries to joints of themselves, except in rare cases at the wrist and ankle where a hopeless smash (produced perhaps by a misshapen bullet) might sometimes call for amputation; or where an ankle resection has produced such a poor result that the foot has become a useless appendage.

In the large joints resection may be required, as will be stated under the different headings of joint injuries. Resection, moreover, may sometimes be sufficient in septic wounds.

Broadly speaking as to treatment of modern wounds: An endeavour should almost always be made in the first instance to convert the

injuries into subcutaneous ones by antiseptics and rest in the hope that the skin wounds will heal. The remarks afore written as to inadvisability of early movement towards the base of patients with broken bones apply with increased force in the case of joints. Once the external wounds are healed passive movement is in most cases desirable to prevent ankylosis. If the wounds do not soon heal it will be because of suppuration having set in. The line of treatment of these septic wounds is in nearly all cases to first try the effect of local antisepsis. If this does not speedily effect improvement resection, or more frequently amputation, will be called for—secondary amputation as it is called.

The old term "intermediate amputation" seems to have gone out of use. It referred to the operation at the outset of general septic infection. This was not found to be a good time for operation. The style of argument as to the respective merits of the intermediate and secondary amputations seems to have been curiously illogical. Operations

undertaken during the fever were often fatal—naturally enough when the infection had gone beyond the local seat of disease. The operation weakened the subject of it and probably, at any rate before antiseptics were in use, created a new local seat. But if the surgeon waited to see if the fever abated and local suppuration became established (*i.e.*, in modern language, when the patient had recovered from the systemic infection by acquiring immunity) he could then operate with enhanced prospect of success. This was called secondary operation. Of course, the only reliable way of comparing the operations would be to take equal numbers of cases, and in one set resort to intermediate, in the other to secondary, operation. All cases which died while waiting for secondary operation should then be counted against that system.

The classical guides to diagnosis of a compound joint injury by gunshot are:

(1) Direction of the bullet.

(2) Escape of synovial fluid.

(3) Crepitation.

(4) Exposure of bones, bone *débris*, or cartilages.

Escape of synovia is now less common owing to the small skin wounds, but in its place we have more frequently filling of the sac with fluid—synovial and hæmorrhagic; effusion, however, as has been stated in another part of the essay, is not a proof of direct injury to a joint.

To take the principal joints in detail:

UPPER EXTREMITY

Shoulder

Injuries of the shoulder joint are generally amenable to conservative treatment. They are not very common compared with some of the other joints. This is due probably to the small area presented by the parts composing the joint. It may be supposed also that bullets coming in a straight line for the head of the humerus laterally (*i.e.*, from the right or left of the man) will be likely to kill by

traversing the upper part of the thorax or root of the neck. (Howbeit, this is mere assumption, as we have no return of the number of killed who have also had shoulder joints injured.) In any direction except the lateral and the vertical the bullet simply wounds the head of the humerus, or perhaps also the acromial end of the clavicle.

If the humeral head be comminuted, complete excision may be performed notwithstanding there may be also acromial lesion or damage to the glenoid cavity. Partial excision seems to offer no particular advantage. If a large portion of the articular surface is to be removed we may as well remove the whole head.

Elbow Joint

Wounds of the elbow joint are more frequently met with. Any or all of the three bones entering into the joint may be injured. Conservatism in the flexed position should be tried unless there is severe comminution and a large flesh wound. If suppuration arises

excision and washing out will meet the majority of cases. The question has arisen whether complete excision of all the articular surfaces should be invariably carried out in the event of the operation being undertaken at all. It would seem right, however, that only the injured bones should be resected—the fewer cut surfaces of bones the better, especially in wounds already septic.

Wrist Joint

Some of the preceding remarks on fractures of the lower ends of the bones of the forearm are applicable with regard to the wrist. Excision here can rarely be required. It is not always successful in leaving a useful hand, and on this account some surgeons are not in favour of excision at all but boldly propose to amputate whenever conservatism fails to meet the case. Yet there can be no doubt it is our moral duty to give the patient the chance of a hand. Operation can always be undertaken later on if required.

Septic states of this joint are apt to be very troublesome and may entail numerous incisions. The disease runs along the tendon sheaths and among the synovial membranes to such an extent that the condition of the hand and wrist sometimes becomes hopeless and amputation is unavoidable.

Lister's operation is usually selected for excision. It may occasionally be sufficient to remove portions of carpal bones, &c., instead of performing the complete operation.

LOWER EXTREMITY

The Hip Joint

Hip-joint injuries are not always easy to diagnose, especially when there is not a complete fracture of the femur or when the wound is external to the joint and the fracture has extended into the joint. In the event of there being either fracture the ordinary signs of extra- or intra-capsular fracture, as the case may be, will be present, though obscured by

the other symptoms of a gunshot injury. But if there be only perforation or grooving, and no synovia, bone dust, or fragments are noticed in the wound, the nature of the injury can only be guessed at from the general symptoms. If after effusion has been absorbed and the external wounds healed any joint trouble remain it may be more easily diagnosed by crepitation, creaking, limitation of movement, pain, and so on. It was formerly taught that distension of the synovial sac was one of the most reliable signs, but, as before shown, this does not always mean that a joint has been penetrated; especially is this the case in the period immediately following the injury; its persistence, or still more its onset, some days after the reception of the wound has a greater diagnostic significance. Doubtful cases need not disturb us, inasmuch as we should treat them as joint injuries until time, or the development of symptoms, has satisfied us either that they are of the more serious nature or that they can in the matter of treatment be relegated to the status of flesh

wounds or to that of fractures outside of and not involving the joint. Still, it must not be supposed that we are unappreciative of the importance of finding out that the bone has been injured in the less severe degree. Wherever possible, endeavours should be made to ascertain the state of affairs by means of the X rays. Because in the slighter bone injuries an apparently innocent wound may suddenly develop into a very bad one when the patient begins to walk about. The skiagram, however, often fails to help us in the solution of diagnosis in this joint.

Suppuration in the hip joint is a very grave matter. It used to be so universal in the pre-antiseptic days that amputation was at one time extensively resorted to in the hope of reducing the mortality. But these amputations were practically always fatal in the field. The military surgeons were then despairing, and looked upon a hip-joint case as doomed; so much so, that some of them even laid down in days the average expectation of life after such injuries. Excision was

then tried, but with hardly any success. Amputation at the hip joint has been a very fatal operation in civil as well as in military life, and has been worse after injuries than for disease; 60 per cent. of deaths was looked upon as a favourable result for amputations of any part of the thigh in civil practice not long ago. In military practice the rate was a little higher, and in the Crimea this operation at the hip joint was fatal to the extent of 100 per cent.

The hopeless condition of matters above described has happily ceased to exist. The operation for all that is still, and always will be, a formidable and often fatal one. It will, therefore, be avoided whenever an alternative course offers any hope. Excision is the operative alternative, and is sufficient for many of the cases in which conservative treatment has to be abandoned.

Initial efforts to secure asepsis are more urgently indicated in this than in any other joint. The size, depth, and difficulty of access of the parts concerned, together with the

proximity to the trunk, combine to cause sepsis of the hip joint to be regarded amongst the most calamitous conditions which can befall the soldier.

Hip-joint injuries do not seem to have been very common in the recent war, though no doubt when the statistics of the whole campaign are available a considerable collection will be found. If their apparent rarity be established eventually by statistical records it will be difficult to account for. Similar reasons to those mentioned in connection with injuries to the shoulder joint can have very slight weight as regards the hip.

The Knee Joint

This joint is one of the most frequently injured. The fact is usually accounted for by saying that the knee is large and much exposed.

From having been considered necessarily fatal unless amputation were resorted to, it has come down to being regarded as more

favourable than the smashing of a shaft. The wounds are chiefly of the perforating type. The external injuries in the soft parts heal readily. Early passive movements are carried on, and in about a month the patient is well. In more serious wounds healing with ankylosis may be the issue. A fracture of the patella may require treating in one of the routine methods. Owing to the ease with which it (the knee joint) can be got at it can be incised and well cleaned out if it chance to become septic. Still, amputation or excision may be required for this condition (sepsis), especially if secondary hæmorrhage occur. Primary operations will be very rarely called for on account of small-bore bullet wounds. Modern excisions of the knee, when the bones are pinned or screwed together, are gratifying enough in their results.

The Ankle Joint

Wounds of this joint have now become of almost more importance than those of the

knee, in that they are more likely to result in permanent disability. This is partly due to the fact that, owing to their position, they are especially liable to be injured by ricochetting bullets, altered in shape and striking irregularly—such as sideways or reverse end on. The joint, too, is somewhat more complicated than that of the knee, and if it become septic more difficult to wash out in all its synovial extensions. It has been thought also to be more liable to sepsis because the foot of the soldier, be he a booted European or a barefooted non-European, is liable to be dirtier than his knees, elbows, &c. For the above reasons amputation is pretty often required in ankle-joint injuries which have suppurated. Excision here is less satisfactory than in other joints. The foot is apt to be rather an encumbrance than otherwise, even if the opera- is successful.

Various forms and degrees of arthrectomy have been advocated, the operator being guided by the injury as to how much to remove ; it is more in the tarsal bones alone

that these minor operations are to be recommended.

When the posterior tibial artery is wounded and the bones very much splintered it may, as already suggested, be advisable to perform primary amputation. Symes' operation may sometimes meet the case.

For all that has been said above it must still be allowed that clean perforations, especially of the tarsal bones alone, are common enough in the ankle joint. All that is meant to be conveyed is that the ankle, like the wrist, has not benefited by the change of arms in the same degree that the knee has.

Owing to its position the ankle joint, in common with the lower end of the nether limb generally, is frequently wounded. In the erect and in the kneeling postures it is caught by ricochets, while in lying down it is usually more consistently exposed than any other part, not excepting even the head. The soldier takes care of his head when not actually firing, but he disregards his feet and frequently raises them thoughtlessly;

when not raised they are frequently crossed and in this position the uppermost heel is exposed.

Class VI

SIMPLE INJURIES TO JOINTS

Injuries of joints without injury to bones remain to be dealt with. They are rare, of course, and call for mere casual comment, being of no special clinical importance provided they do not become septic.

The direction of the projectile guides in, and synovial fluid escaping renders certain, the diagnosis of an opened joint. There may be only effusion and no escape of synovia. Effusion in itself is not a reliable sign of perforation of a joint cavity, as is explained below.

Under ordinary circumstances no treatment is required beyond that for the external wounds.

If the bullet be lodged in the joint or in its immediate vicinity so as to interfere

with free movement its removal will be required.

In the event of the joint becoming septic the management required is the same as in cases of suppurating joint wounds due to extension of a fracture into the joint or to a direct bone wound in the joint. The ground need not be gone over again—local antisepsis, resection, or amputation will be demanded.

Inflammation of a joint may be due to a gunshot wound in its neighbourhood, not of necessity very near neighbourhood. This may be sympathetic (to use a figure of speech) or due to the shock of concussion ; it is analogous to the inflammation consequent on sprain or contusion, in which injuries the synovial trouble is by no means confined to the area actually sprained or contused. Inflammatory action of this nature is sometimes accompanied, both locally and generally, by rise of temperature. It must therefore be borne in mind, in connection with diagnosis, that synovial inflammation and effusion near

to a bullet wound, even if it be in conjunction with a rise of body temperature, does not of itself prove that the joint has been penetrated.

General Conclusions

(1) That, coincident with the adoption of the new bullet and rifle, wounds of bones and joints have become more amenable to treatment.

(2) That to some extent this is due to the alteration in the arms and projectiles.

(3) That to a great extent it is the result of a better understanding and practice of aseptic and antiseptic methods.

(4) That in a lesser degree it is contributed to by improved medical, supply, transport, and ordnance services.

SPLINTS FOR ACTUAL FIELD SERVICE

The splints now supplied should be continued. It would be well if a few of the plain wooden splints formerly allowed could be again included in the appliances. They were always useful and they weigh little. It is easy to cut them up to any size required.

As an addition to the present list it would seem desirable to supply some stout hoop iron, or its equivalent, in long pieces (about $4\frac{1}{2}$ feet) capable of being bent. From this material can be fashioned splints of all shapes, suitable for thigh wounds, resections, &c. These would meet the requirements of those medical officers who wish to treat fractures by extension with weights. They can be adapted closely to the whole extent of a limb, and an arch may be made so as to allow of the dressing of a wound and the examination

of a fracture without moving the splint. It is chiefly in the stationary hospitals that they would be used. Stationary hospitals, in this respect, are held to include all extemporised fixed institutions, the establishment of which may be necessitated by the course of events. Counter extension apparatus with bags for sand weights are already to be found in the 98-pattern field fracture box. Plaster of Paris and pasteboard are also supplied and are useful in some circumstances.

In the actual battlefield manufactured splints in sufficient numbers for big engagements can hardly ever be provided. They are, however, rarely absolutely necessary; sticks, bayonets, scabbards, and rifles always prove sufficient, and they have this great merit, that they are almost invariably at hand close by the wounded man.

FIRST AID

A few lines on the subject of first aid, with special reference to fractures, may form an appropriate conclusion to this essay.

The prevailing idea among the troops is that wounded should be hurried off the field as soon as possible. They believe that many men bleed to death if not promptly attended to; also that any man who has undergone the trivial amount of training given to the regimental bearer can be entrusted with the dressing and removal. If no bearer is at hand the first available man takes upon himself the duty of assisting the wounded.

It is difficult to find adequate remedy for these errors of conception as to what constitutes useful first aid. Public opinion and the influence of custom must be reckoned with. All medical men know well enough that few people bleed to death on the battlefield, and that scarcely one of those few could be saved

except by a man actually on the spot when the wound was inflicted. It seems, therefore, that we ought to have courage enough to calm men's minds by telling them the truth about this matter, because the hasty removal of wounded from the field really does more harm than good.

In the effort to clear the ground of wounded while the battle is in progress fractured bones are joggled about by rough hands of men in a hurry to get out of harm's way themselves. The calmest hero that ever earned a V.C. must have *some* regard for his own safety, and is not likely to make good surgical practice when bullets are flying about him. The V.C. race at regimental sports affords an idea of the pleasures of being saved and of the popular conception of how it is done. Imagine men with fractured thighs, not to speak of other injuries, being carried at night along rugged tracks in the two-handed seat, or in the blanket stretcher (which is, by the way, a most inferior kind of conveyance for use anywhere but on the parade ground) without

splint of any kind on their tortured limbs. How needless the sufferings of these unfortunate victims of misguided kindness. If we were fighting an uncivilised people there might be some justification for such treatment, but otherwise it would be kinder to leave the wounded on the ground till daylight. The latter procedure, however, would seem to the public to be much too cruel, and the officer responsible for their being left would probably have to suffer for his temerity in establishing such a precedent.

But every country is not so suitable as South Africa for letting the wounded lie, and it would, of course, be fatal to leave them out on winter nights in some colder climates.

The best thing would be to have all the soldiers trained (properly trained) in first aid and stretcher work. A few of the hours and hours idled away in barracks might well be devoted to this. The regular bearers are now only two per company and are indifferently trained. In nine cases out of ten

these trained men are not at hand when wanted. They can't be everywhere, and in the present system of fighting in widely extended order the area of ground covered by a company is so great that no two men could be able to look after a company's wounded. Moreover, at a very early stage in the campaign they are liable to be invalided down or killed, and there is no one to replace them. The R.A.M.C. bearers, it is true, remove a great many wounded, but the same causes which have rendered the regular bearer less useful than of old have made it difficult for a bearer company to cover the ground over which a brigade has fought, and the bearer companies cannot be increased indefinitely or we shall have a medical army nearly equal to the combatant portion. A universal first aid course seems the only remedy for the existing deficiency.

Another aspect of the above question of early attention to wounded is that the casualties among the bearers themselves are so high. During the recent campaign it

seems to have often been expected that while all the fighting men were lying down the stretcher bearers could stand up and work. There was a widespread idea that the tiny red cross on the arm protected the wearer. Apart from the fact that it is invisible at a few hundred yards, even when it happens to be in the enemy's line of sight, it may be confidently set down that the cross has no protective value whatever in anything like a general engagement.

Again, owing to the widely extended order of the troops, it is impossible to distinguish wounded from unwounded at all parts of the area covered by a company with only two bearers. The writer has more than once, when already exhausted, gone some distance in the hot sun to examine a prostrate figure, and found only a man resting.

Owing to the difficulty of communication over a wide field being impossible on foot, and often impracticable to the mounted man, it would seem desirable to have some system of signalling for the purpose. It would

perhaps help matters along if every soldier carried a red handkerchief to be displayed by himself or a comrade when wounded. This refers to present conditions. If every soldier understood "first aid" it would be unnecessary.

It would seem that the most grateful first aid to the injured man is an injection of morphia, and there seems to be no reason why in these days of tabloids a bearer should not be well trained enough to give this injection just as a nurse does in a civil hospital. It might be a better thing to have each bearer supplied with a large hypodermic syringe containing morphia solution. A man of mechanical genius would find it a simple matter to invent a syringe which would only inject, say, $\frac{1}{4}$ grain at one time, and before another injection could be made some special mechanism should require readjustment. The process of procuring water, dissolving a tabloid in it, and getting the solution into a syringe, is tedious enough in the battlefield, especially in the dark. The

risks of inoculating the wounded with disease would not be greater than they are now ; no one thinks (or, at any rate, is capable if he does think of it) of sterilising the hypodermic needle between each injection under such circumstances.

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